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PLANETARY GEAR TRANSMISSION

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This invention relates to gear transmissions, and more particularly to transmissions of the type having central and non-central gears (for example, planetary gear transmissions) and which incorporate means for insuring that the load on the non-central gears is at all times distributed equally among them. It should be understood that the term "gear transmissions" in connection with the present invention is not limited to transmissions with rotatable planet gear carriers but also includes such transmissions in which the non-central gear carriers are stationary. This application is a continuation in part of application Serial No. 319,350, now abandoned, filed November 7, 1952, by the present applicant.

Gear transmissions are known according to which the equal load distribution among the non-central gears is accomplished by providing a flexible connection between at least one central gear and that part of the assembly which takes up the torque of said central gear, so that this central gear can adjust itself in accordance with a balancing of forces acting upon it. The term "central gear" is of course intended to refer to either a sun gear or orbit gear of a transmission. The flexible connection mentioned above must comprise two flexible joints as otherwise the correct mesh of teeth between the central gear and the non-central gears would be impaired in consequence of angular misalignments which would arise between the axes of the self-adjusting central gear and the non-central gear in mesh therewith. An example of such a known structure is a planetary gear transmission the self-adjusting central gear of which is connected to that part of the assembly which takes up the torque of said central gear, by means of a coupling member in the form of a double-jointed toothed coupling. Such constructions have been found to be comparatively cumbersome and expensive to produce.

It is an object of the present invention to overcome the deficiencies of previously known gear transmissions of this type and to provide an improved and simplified gear transmission which provides for continuously equal load distribution among the non-central gears in a simplified and less cumbersome way and with decreased production cost.

It is another object to provide an improved gear transmission of this nature which is easy to maintain, inexpensive to produce, and compact in structure, and may take the form of a transmission with a rotatable planet carrier, or one in which the non-central gear carrier is stationary.

Other objects, features and advantages of the present invention will become apparent from the subsequent description, taken in conjunction with the accompanying drawings.

In the drawings:

FIGURE 1 is a longitudinal section through an embodiment of a planetary gear transmission constructed according to the invention, the transmission being of the type in which the planet carrier rotates;

FIGURE 2 is a perspective view (slightly exaggerated) of a tooth designed in conformity with the principles of the invention;

FIGURE 3 is a fragmentary perspective view of a portion of the orbit gear in the transmission of FIGURE 1, and

FIGURE 4 is a longitudinal section through another

embodiment of the invention comprising a transmission having a stationary gear carrier.

In general terms, the invention comprises a gear transmission in which at least one of the central gears (that is, the orbit or sun gear) and the non-central gears have mating sets of teeth one set of which has flanks which are slightly crowned in a longitudinal direction, so that limited rocking action may take place between this central gear and non-central gears while they are in mesh. This central gear has an axial extension which connects it with that part of the assembly taking up the torque of said central gear, such part being either a shaft or the stationary housing. The connection between this extension and part is flexible to permit limited angular shifting of the extension with respect to the part. This connection, taken together with the crowned teeth, constitutes flexible coupling means which not only permits radial displacement of the central gear to maintain equal load distribution among the non-central gears, but also permits relative angular shifting between the axes of the central gear and the non-central gears, this angular displacement not affecting the correct meshing engagement between the driving teeth of the central gear and the non-central gears. The crowned teeth may be provided only on the non-central gears, or on the teeth of one or both central gears instead of or in addition to the non-central gears. The construction may be applied to transmissions in which the planet carrier rotates or in constructions where the carrier is fixed to the housing.

Referring more particularly to the drawings, the construction as shown in FIGURES 1–3 comprises a casing **1** having arranged therein a planetary gear transmission which comprises an inner central gear or sun gear **2**, a plurality of planet gears **3**, which may be in any desired number, for instance, three as in the illustrated embodiment, and an outer central gear **6**, sometimes referred to as a ring or orbit gear. The three planet gears **3** are preferably equidistantly spaced in a circumferential direction around sun gear **2**. Planet gears **3** are respectively mounted on shafts or pins **4** carried by a planet carrier **5**. This carrier is secured to one transmission shaft **7** rotatably journaled in casing **1**. The other transmission shaft **8**, the axis of which is in alignment with the axis of shaft **7**, is likewise rotatably journaled in casing **1**. That end of transmission shaft **8** which is adjacent the planetary gear transmission is provided with coupling teeth **9** interfitting with corresponding teeth **10** of an extension **2***a* on sun gear **2**, retaining rings **10***a* being provided to hold the coupling teeth in position. Similarly orbit gear **6** is provided with an extension **11** carrying coupling teeth **12** which interfit with corresponding teeth **13** of a ring **14**. Ring **14** is fixed to casing **1** which represents the element or part taking up the torque of orbit gear **6**. It should be noted that teeth **9**, **10**, **12** and **13** are not gear teeth in the ordinary sense since they do not advance over each other or go into and out of mesh. Instead, they may be referred to as coupling teeth and as such, relative angular movement of a limited nature may take place between the sets of teeth without affecting their ability to transmit torque. Each set of coupling teeth **9**, **10** and **12**, **13** thus constitutes, in effect, a single flexible or universal joint.

According to the invention, the flanks of some or all of the gear teeth in the planetary transmission are slightly crowned. Preferably, the arrangement is such that the teeth of planet gears **3** are slightly crowned in the manner shown as exaggerated in FIGURE 2. It will be noted that the crown is in a longitudinal direction along each tooth, so that limited relative angular displacement between the planet gears on the one hand and either the sun or orbit gear on the other hand will not affect the correct conjugate action between these teeth as they move into and out of mesh. It should be understood that sun gear **2**